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International Space Station

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International Space Station
Russian Space Stations

Introduction

The International Space Station, which will be assembled between late 1997 and mid-2002, will contain many Russian hardware elements developed in the nearly 30 years of the Russian space station program. The history of Russian space stations is one of gradual development marked by upgrades of existing equipment, reapplication to new goals of hardware designed for other purposes, rapid recovery from failures, and constant experimentation. The earliest Salyut stations were single modules, designed for only temporary operations. *Mir*, the most recent station, is a permanent facility in orbit for 9 years made up of four separately-launched modules. Additional modules are scheduled to be added in 1995 during International Space Station Phase I, when the U.S. shuttle *Atlantis* will dock several times with *Mir* and U.S. astronauts will live on the station for months at a time.

Prelude to Space Stations (1903-1964)

In 1903, Russian schoolteacher Konstantin Tsiolkovsky wrote *Beyond the Planet Earth*, a work of fiction based on sound science. In it, he described orbiting space stations where humans would learn to live in space. Tsiolkovsky believed these would lead to self-contained space settlements and expeditions to the Moon, Mars, and the asteroids. Tsiolkovsky wrote about rocketry and space travel until his death in 1935, inspiring generations of Russian space engineers.

Soviet engineers began work on large rockets in the 1930s. In May 1955, work began on the Baikonur launch site in central Asia. In August 1957, the world's first intercontinental ballistic missile lifted off from Baikonur on a test flight, followed by the launch of *Sputnik 1*, world's first artificial satellite, on October 4, 1957. On April 12, 1961, Yuri Gagarin lifted off from Baikonur in the *Vostok 1* capsule, becoming the first human in space.

A year later, Soviet engineers described a space station comprised of modules launched separately and brought together in orbit. A quarter-century later, in 1987, this concept became reality when the *Kvant* module was added to the *Mir* core station.

First-Generation Stations (1964-1977)

First-Generation		***Stations***	
Salyut 1	civilian	1971	First space station
Unnamed	civilian	1972	Failure
Salyut 2	military	1973	First *Almaz* station; failure
Cosmos 557	civilian	1973	Failure
Salyut 3	military	1974-75	*Almaz* station
Salyut 4	civilian	1974-77	
Salyut 5	military	1976-77	Last *Almaz* station

First-generation space stations had one docking port and could not be resupplied or refueled. The stations were launched unmanned and later occupied by crews. There were two types: *Almaz* military stations and *Salyut* civilian stations. To confuse Western observers the Soviets called both kinds *Salyut*.

The *Almaz* military station program was the first approved. When proposed in 1964, it had three parts: the *Almaz* military surveillance space station, Transport Logistics Spacecraft for delivering soldier-cosmonauts and cargo, and Proton rockets for launching both. All of these spacecraft were built, but none was used as originally planned.

Soviet engineers completed several *Almaz* station hulls by 1970. The Soviet leadership ordered *Almaz* hulls transferred to a crash program to launch a civilian space station. Work on the Transport Logistics Spacecraft was deferred, and the *Soyuz* spacecraft originally built for the Soviet manned Moon program was reapplied to ferry crews to space stations. *Salyut 1*, the first space station in history, reached orbit unmanned atop a Proton rocket on April 19, 1971.

The early first-generation stations were plagued by failures. The crew of *Soyuz 10*, the first spacecraft sent to *Salyut 1*, was unable to enter the station because of a docking mechanism problem. The *Soyuz 11* crew lived aboard *Salyut 1* for three weeks, but died during return to Earth because the air escaped from their *Soyuz* spacecraft. Then, three first-generation stations failed to reach orbit or broke up in orbit

before crews could reach them. The second failed station was *Salyut 2*, the first *Almaz* military station to fly.

The Soviets recovered rapidly from these failures. *Salyut 3*, *Salyut 4*, and *Salyut 5* supported a total of five crews. In addition to military surveillance and scientific and industrial experiments, the cosmonauts performed engineering tests to help develop the second-generation space stations.

Second-Generation Stations (1977-1985)

Second-Generation Stations			
Salyut 6	civilian	1977-82	
Salyut 7	civilian	1982-91	Last staffed in 1986

With the second-generation stations, the Soviet space station program evolved from short-duration to long-duration stays. Like the first-generation stations, they were launched unmanned and their crews arrived later in *Soyuz* spacecraft. Second-generation stations had two docking ports. This permitted refueling and resupply by automated *Progress* freighters derived from *Soyuz*. *Progress* docked automatically at the aft port, and was then opened and unloaded by cosmonauts on the station. Transfer of fuel to the station took place automatically under supervision from the ground.

A second docking port also meant long-duration resident crews could receive visitors. Visiting crews often included cosmonaut-researchers from Soviet bloc countries or countries sympathetic to the Soviet Union. Vladimir Remek of Czechoslovakia, the first space traveler not from the U.S. or the Soviet Union, visited Salyut 6 in 1978.

Visiting crews relieved the monotony of a long stay in space. They often traded their *Soyuz* spacecraft for the one already docked at the station because *Soyuz* had only a limited lifetime in orbit. Lifetime was gradually extended from 60-90 days for the *Soyuz Ferry* to more than 180 days for the *Soyuz-TM*. The *Soyuz* crew transfer vehicle for the International Space Station will have a lifetime of more than a year.

Salyut 6 Key Facts

- The station received 16 cosmonaut crews, including six long-duration crews. The longest stay time for a *Salyut 6* crew was 185 days. The first *Salyut 6* long-duration crew stayed in orbit for 96 days, beating the 84-day world record for space endurance established in 1974 by the last *Skylab* crew.
- The station hosted cosmonauts from Hungary, Poland, Romania, Cuba, Mongolia, Vietnam, and East Germany.
- Twelve *Progress* freighters delivered more than 20 tons of equipment, supplies, and fuel.
- An experimental transport logistics spacecraft called *Cosmos 1267* docked with *Salyut 6* in 1982. The transport logistics spacecraft was originally designed for the *Almaz* program. *Cosmos 1267* proved that large modules could dock automatically with space stations, a major step toward the multimodular *Mir* station and the International Space Station.

Salyut 7 Key Facts

- *Salyut 7*, a near twin of *Salyut 6*, was home to 10 cosmonaut crews, including six long-duration crews. The longest stay time was 237 days.
- Cosmonauts from France and India worked aboard the station, as did the first female space traveler since 1963.
- Thirteen *Progress* freighters delivered more than 25 tons of equipment, supplies, and fuel to *Salyut 7*.
- Two experimental transport logistics spacecraft, *Cosmos 1443* and *Cosmos 1686*, docked with *Salyut 7*. *Cosmos 1686* was a transitional vehicle, a transport logistics spacecraft redesigned to serve as an experimental space station module.
- *Salyut 7* was abandoned in 1986 and reentered Earth's atmosphere over Argentina in 1991.

Third-Generation Station: Mir (1986-present)

Third-Generation Station			
Mir	civilian	1986-present	First permanent station

Mir is the first permanent space station. The station has been in orbit for 9 years, and staffed continuously for the past 5 years. The complex presently weighs more than 70 tons, and consists of the *Mir* core and the *Kvant*, *Kvant 2*, and *Kristall* modules. *Mir* measures more than 107 feet long with docked *Progress-M* and *Soyuz-TM* spacecraft, and is about 90 feet wide across its modules.

Mir Module Descriptions

- The *Mir* core resembles *Salyut 7*, but has six ports instead of two. Fore and aft ports are used primarily for docking. Four radial ports in a node at the station's front are for berthing large modules. The core weighed 20.4 tons at launch in 1986.
- *Kvant* was added to the *Mir* core's aft port in 1987. This small, 11-ton module contains astrophysics instruments and life support and attitude control equipment.
- *Kvant 2*, added in 1989, carries an EVA airlock, solar arrays, and life support equipment. The 19.6-ton module is based on the transport logistics spacecraft originally intended for the *Almaz* military space station program of the early 1970s.
- *Kristall*, added in 1990, carries scientific equipment, retractable solar arrays, and a docking node equipped with a special androgynous docking mechanism designed to receive spacecraft weighing up to 100 tons. Originally, the Russian *Buran* shuttle, which made one unmanned orbital test flight in 1988, would have docked with *Mir* using the androgynous unit. Space Shuttle *Atlantis* will use the androgynous unit to dock with *Mir* for the first time on the STS-71 mission in June 1995. On STS-74, in October 1995, *Atlantis* will permanently attach a docking module to *Kristall*'s androgynous docking unit. The docking module will improve clearance between *Atlantis* and *Mir's* solar arrays on subsequent docking flights. The 19.6-ton *Kristall* module is based on the transport logistics spacecraft originally designed to carry Soviet soldier-cosmonauts to the *Almaz* military space stations.

Modules for *Mir's* radial berthing ports first dock at the front port. Each module carries a manipulator arm which locks into a socket on *Mir*. The arm pivots the module into place at the proper radial port. *Kristall* and *Kvant 2* are currently located opposite each other, giving the *Mir* complex a "T" shape. The

Kristall module will be moved during International Space Station Phase I to permit the STS-71 docking in June and to make way for a new module called *Spektr*.

Mir Key Facts

- An important goal of the *Mir* program has been to maintain a permanent human space presence. Except for two brief periods (July 1986-February 1987; April-September 1989), Russian cosmonauts have lived aboard *Mir* continuously for the past 9 years, demonstrating proven experience in space station operations.
- Dr. Valeri Polyakov arrived on *Mir* on *Soyuz-TM 18* in January 1994 and returned to Earth on *Soyuz-TM 20* on March 21, 1995. He lived in orbit for more than 438 days, a new world record.
- Through 1994, 16 long-duration crews lived and worked on *Mir*. In all, 19 piloted craft have docked with the station.
- Cosmonaut-researchers from Afghanistan, Austria, Britain, Bulgaria, the European Space Agency, France, Germany, Japan, Kazakhstan, and Syria have visited *Mir*. European and French cosmonauts lived on *Mir* for as long as a month. U.S. astronauts are slated to spend up to 5 months on the station.
- More than 40 *Progress* and *Progress-M* freighters have delivered more than 100 tons of supplies and fuel to *Mir*. The improved *Progress-M* occasionally carries a capsule for returning to Earth a small quantity of experiment results and industrial products from the station. Occasionally cargo comes back to Earth with cosmonauts in *Soyuz-TM* capsules. Beginning with STS-71, the shuttle will return to Earth more industrial products and experiment samples than is possible using the *Progress-M* capsules or *Soyuz-TM*. In addition, the shuttle could be used to return components from *Mir*'s exterior, such as solar arrays, for studying the effects of long exposure to space conditions–a capability not available with *Progress-M* and *Soyuz-TM*.
- Three new modules are scheduled to be added to Mir in 1995. *Spektr* and *Priroda* carry U.S. experiments and equipment and will be launched on Proton rockets from Baikonur Cosmodrome in Kazakhstan. The Russian-built Docking Module will be carried into orbit by *Atlantis* on STS-74 in November 1995.
- *Mir* recently completed its 50,000th orbit of Earth. In 9 years the Russian station has traveled about 1.5 billion miles.